

Exhibit 1

How Computers Work

Millennium Edition

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que®

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How a Super-VGA Display Works

2 The DAC compares the digital values sent by the PC to a *look-up table* that contains the matching voltage levels for the three primary colors needed to create the color of a single pixel. In a normal VGA adapter, the table contains values for 262,144 possible colors, of which 256 values can be stored in the VGA adapter's memory at one time. Super-VGA adapters have enough memory to store 16 bits of information for each pixel (16,000 colors, called *high color*) or 24 bits a pixel (16,777,216 shades—or *true color*).

VOLTAGES			
RED	GREEN	BLUE	
5	2.5	1	
5	2.5	2	
5	2.5	3	
5	2.5	4	
5	2.5	5	

3 The adapter sends signals to three electron guns located at the back of the monitor's *cathode-ray tube (CRT)*. Through the vacuum inside the CRT, each electron gun shoots out a stream of electrons, one stream for each of the three primary colors. The intensity of each stream is controlled by the signals from the adapter.

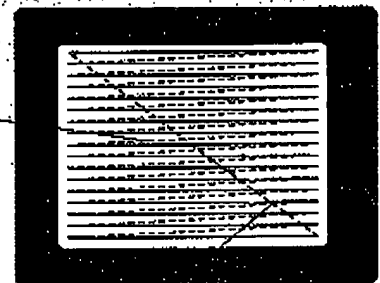
4 The adapter also sends signals to a mechanism in the neck of the CRT that focuses and aims the electron beam. The mechanism, a *magnetic deflection yoke*, uses electromagnetic fields to steer the path of the electron streams. The signals sent to the yoke help determine the monitor's *resolution*—the number of pixels displayed horizontally and vertically—and the monitor's *refresh rate*, which is how frequently the screen's image is redrawn.

1 Digital signals from the operating environment or application software go to the *super video graphics array (SVGA)* adapter. The adapter runs the signals through a circuit called a *digital-to-analog converter (DAC)*. Usually the DAC circuit is contained within one specialized chip, which actually contains three DACs—one for each of the primary colors used in a display: red, blue, and green.

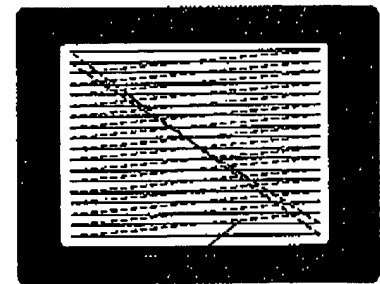
5 The beams pass through holes in a metal plate called a *shadow mask*. The purpose of the mask is to keep the electron beams precisely aligned with their targets on the inside of the CRT's screen. The CRT's *dot pitch* is the measurement of how close the holes are to each other; the closer the holes, the smaller the dot pitch. This, in turn, creates a sharper image. The holes in most shadow masks are arranged in triangles, with the important exception of those of the Sony Trinitron CRT used by many monitor manufacturers. The Trinitron's holes are arranged as parallel slots.

6 The electrons strike the phosphors coating the inside of the screen. Phosphors are materials that glow when they are struck by electrons. Three different phosphor materials are used—one each for red, blue, and green. The stronger the electron beam that hits a phosphor, the more light the phosphor emits. If each red, green, and blue dot in an arrangement is struck by equally intense electron beams, the result is a dot of white light. To create different colors, the intensity of each of the three beams is varied. After a beam leaves a phosphor dot, the phosphor continues to glow briefly, a condition called *persistence*. For an image to remain stable, the phosphors must be reactivated by repeated scans of the electron beams before the persistence fades away.

7 After the beams make one horizontal sweep across the screen, the electron streams are turned off as the magnetic yoke refocuses the path of the beams back to the left edge of the screen at a point just below the previous *scan line*. This process is called *raster scanning*.



8 The magnetic deflection yoke continually changes the angles at which the electron beams are bent so that they sweep across the entire screen surface from the upper-left corner of the screen to the lower-right corner. A complete sweep of the screen is called a *field*. Upon completing a field, the beams return to the upper-left corner to begin a new field. The screen is normally *redrawn*, or *refreshed*, about 60 times a second.



9 Some display adapters scan only every other line with each field, a process called *interlacing*. Interlacing allows the adapter to create higher resolutions—that is, to scan more lines—with less expensive components. But the fading of the phosphors between each pass can be noticeable, causing the screen to flicker.